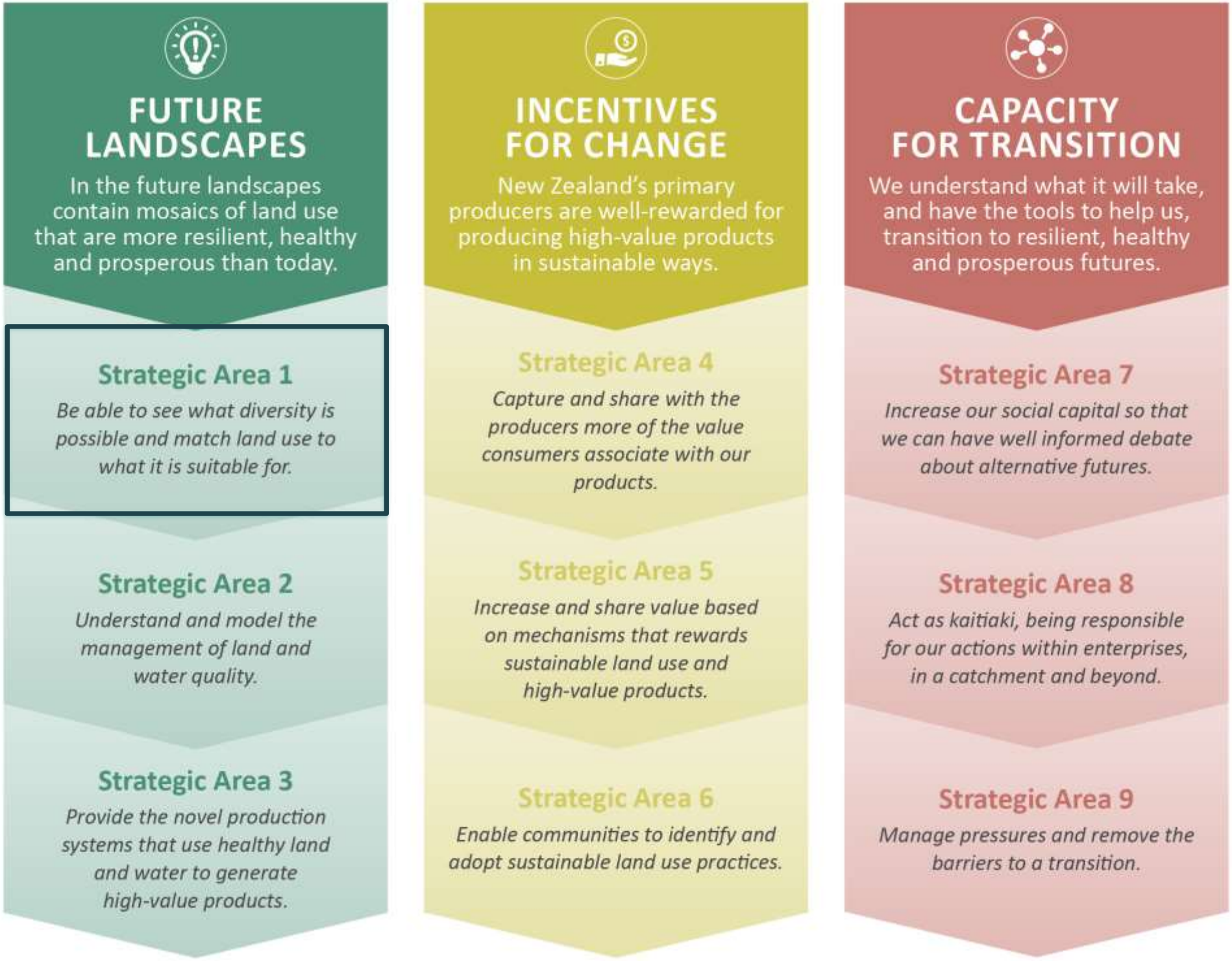
Nitrogen attenuation via benign denitrification

Dave Horne
Massey University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In the future landscapes contain mosaics of land use that are more resilient, healthy and prosperous than today.
Strategic Area 1
Be able to see what diversity is possible and match land use to what it is suitable for.
Strategic Area 2
Understand and model the management of land and water quality.
Strategic Area 3
Provide the novel production systems that use healthy land and water to generate high-value products.
INCENTIVES FOR CHANGE
New Zealand's primary producers are well-rewarded for producing high-value products in sustainable ways.
Strategic Area 4
Capture and share with the producers more of the value consumers associate with our products.
Strategic Area 5
Increase and share value based on mechanisms that rewards sustainable land use and high-value products.
Strategic Area 6
Enable communities to identify and adopt sustainable land use practices.
CAPACITY FOR TRANSITION
We understand what it will take, and have the tools to help us, transition to resilient, healthy and prosperous futures.
Strategic Area 7
Increase our social capital so that we can have well informed debate about alternative futures.
Strategic Area 8
Act as kaitiaki, being responsible for our actions within enterprises, in a catchment and beyond.
Strategic Area 9
Manage pressures and remove the barriers to a transition.

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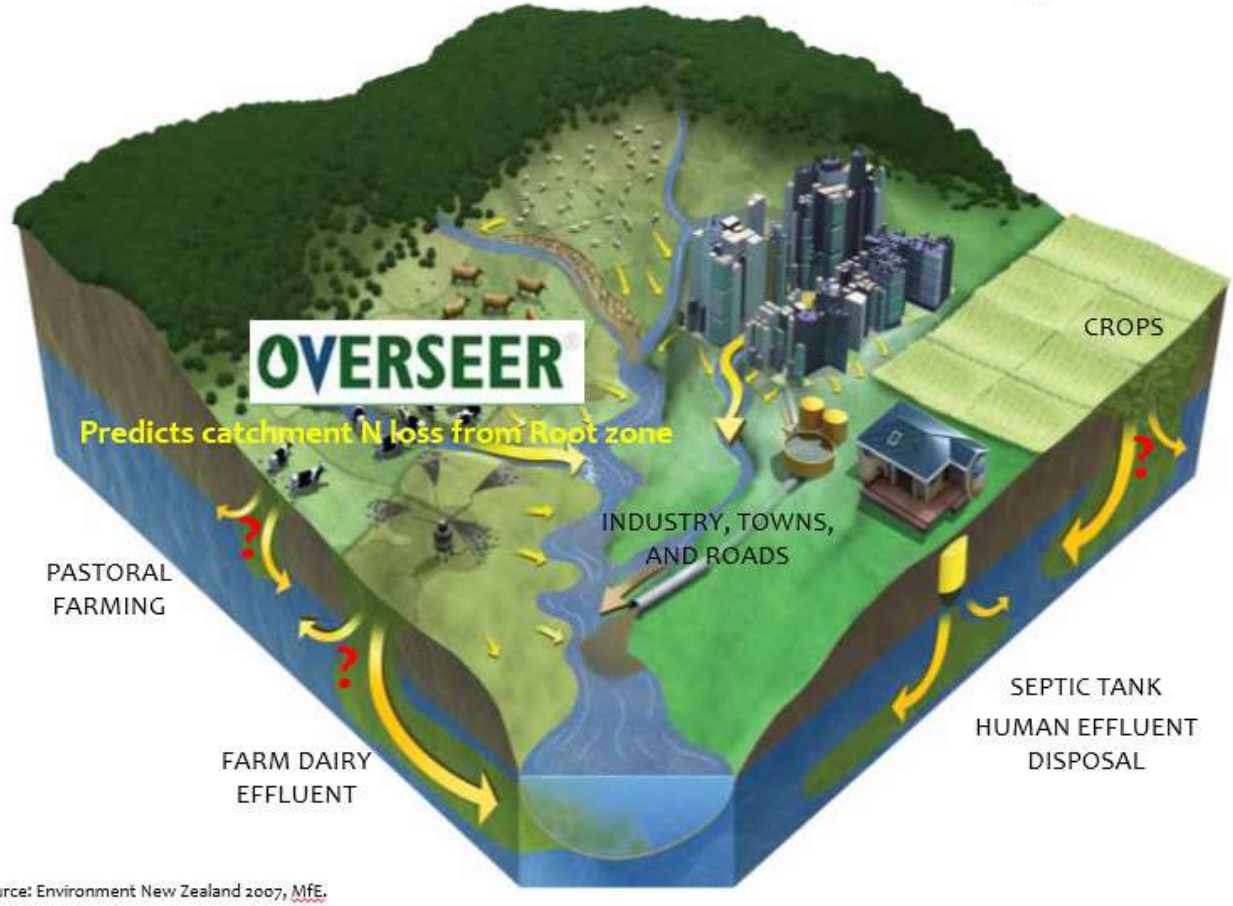
What is the problem?

Sources and contributions to nutrient loadings?



Source: Environment New Zealand 2007, MfE.

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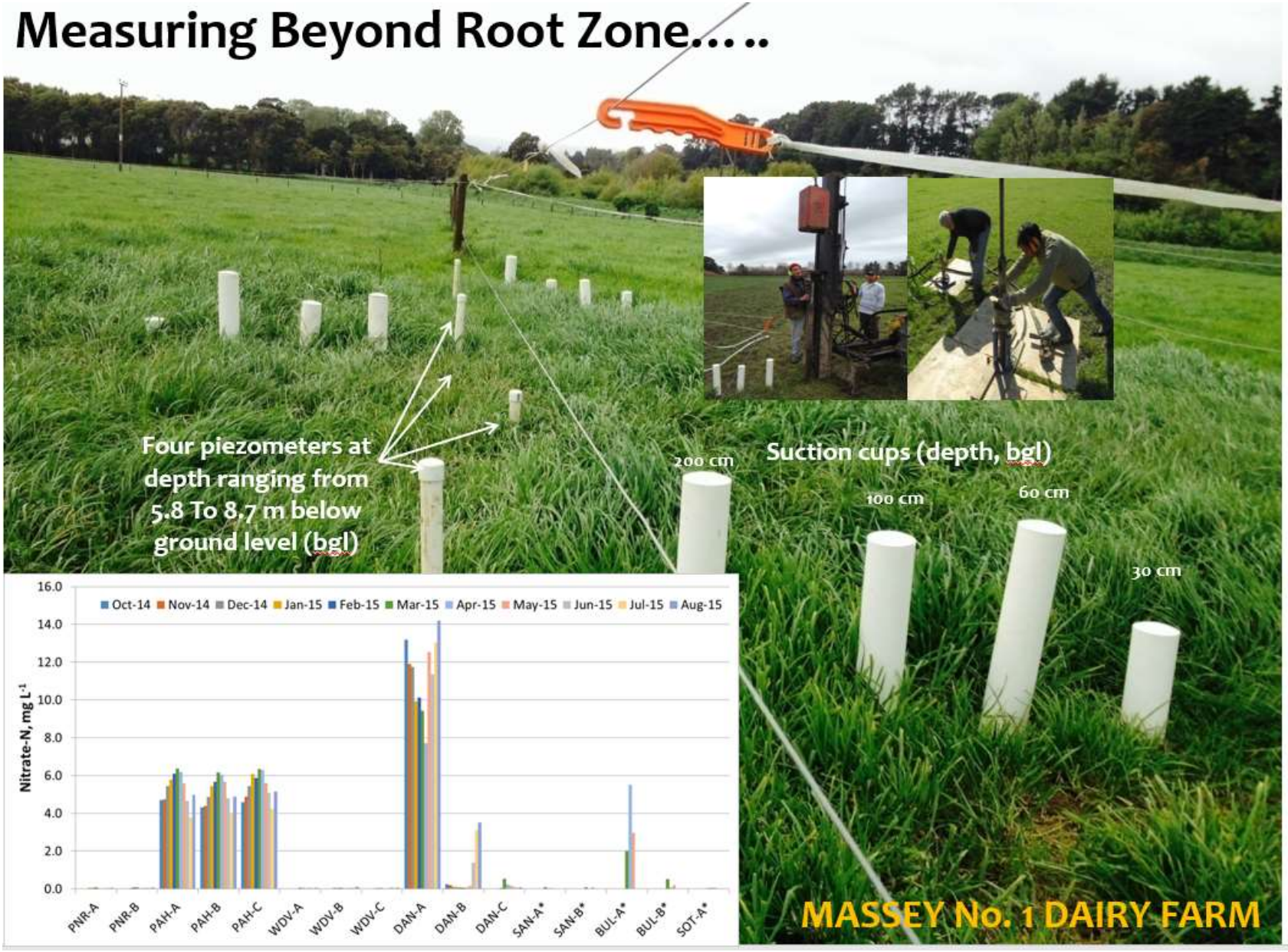
What is the solution?



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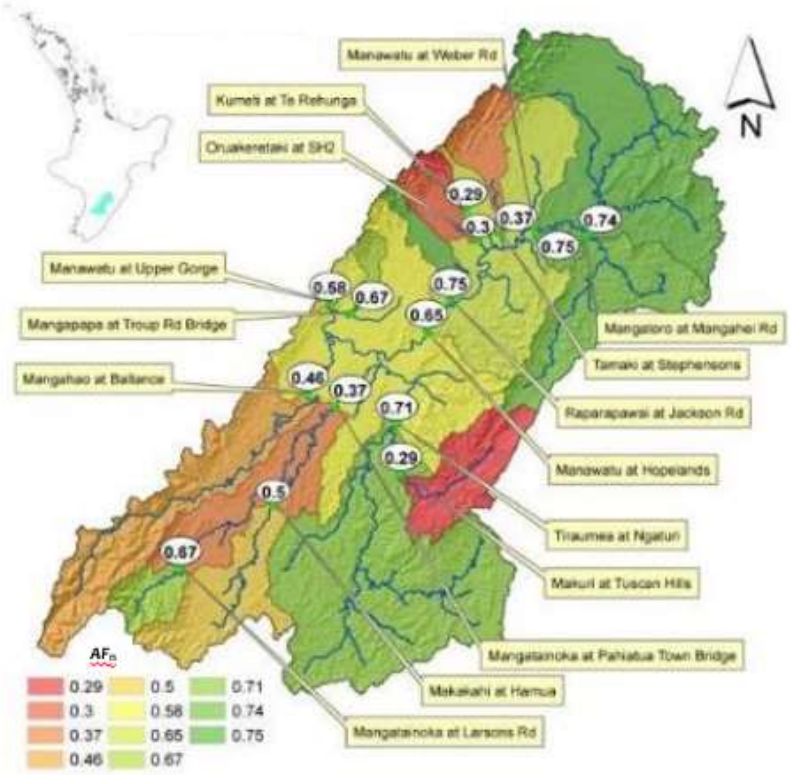
What is the solution?

Map of N attenuation factors* – Tararua GWMZ, Manawatu



'0' - indicates no nitrogen reduction,

'1' - indicates 100% nitrogen reduction

* Indicative assessment based on the OVERSEER predicted average nitrogen leaching rates (kg ha^{-1} yr^{-1}) from the major landuses, and the measured average soluble inorganic nitrogen load (kg yr^{-1}) in streams/rivers across the sub-catchments.

Source: Ahmed Elwan, PhD Student, Massey University

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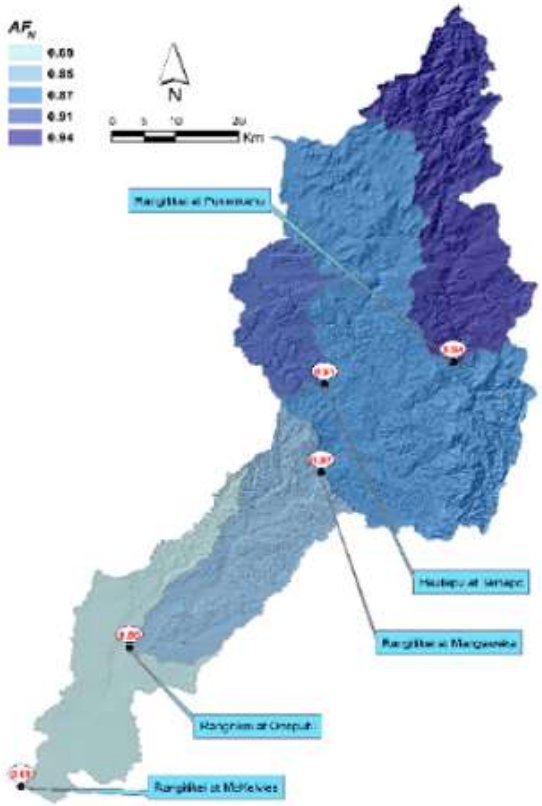
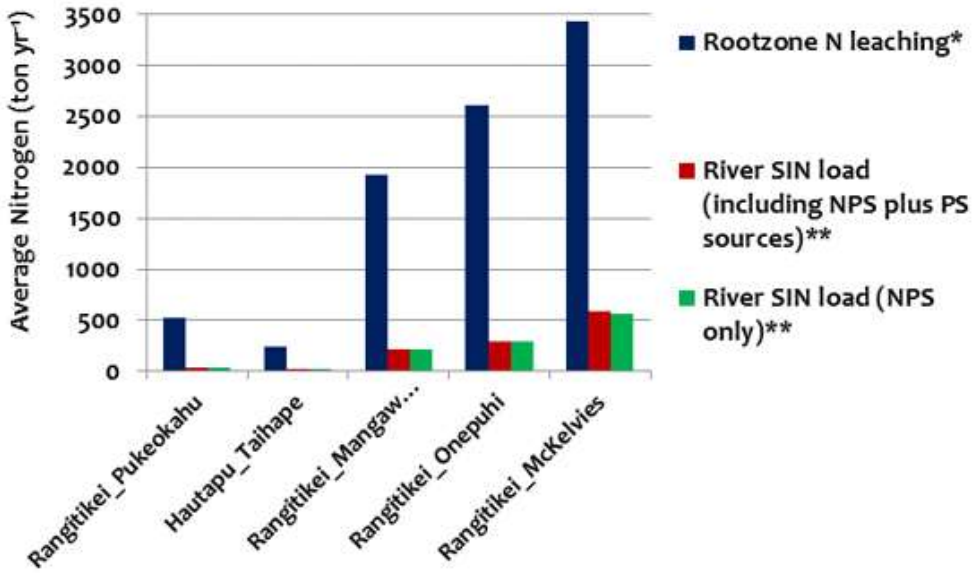
What is the solution?

Estimates of N leaching and river N loads in the Rangitikei catchment





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What is the solution?

Prediction of attenuation capacity at a finer scale

AF_n class	AF_n value	Soil types (soil texture, drainage and carbon classes)*	Rock Types (geology)
Low	0.10 – 0.30	e.g. Stony sandy loam, and sand & stony gravel; soil carbon class 5; and soil drainage classes 4 and 5, and artificial drainage	e.g. Gravels
Medium	0.35 – 0.65	e.g. Sandy and silt loams; soil carbon classes 3 and 4; and soil drainage class 3	e.g. Sandstone, limestone, and siltstone
High	0.70 – 0.95	e.g. Heavy silt loam, clay loam and peaty loam; soil carbon classes 1 and 2; and soil drainage classes 1 and 2	e.g. Mudstone and peat

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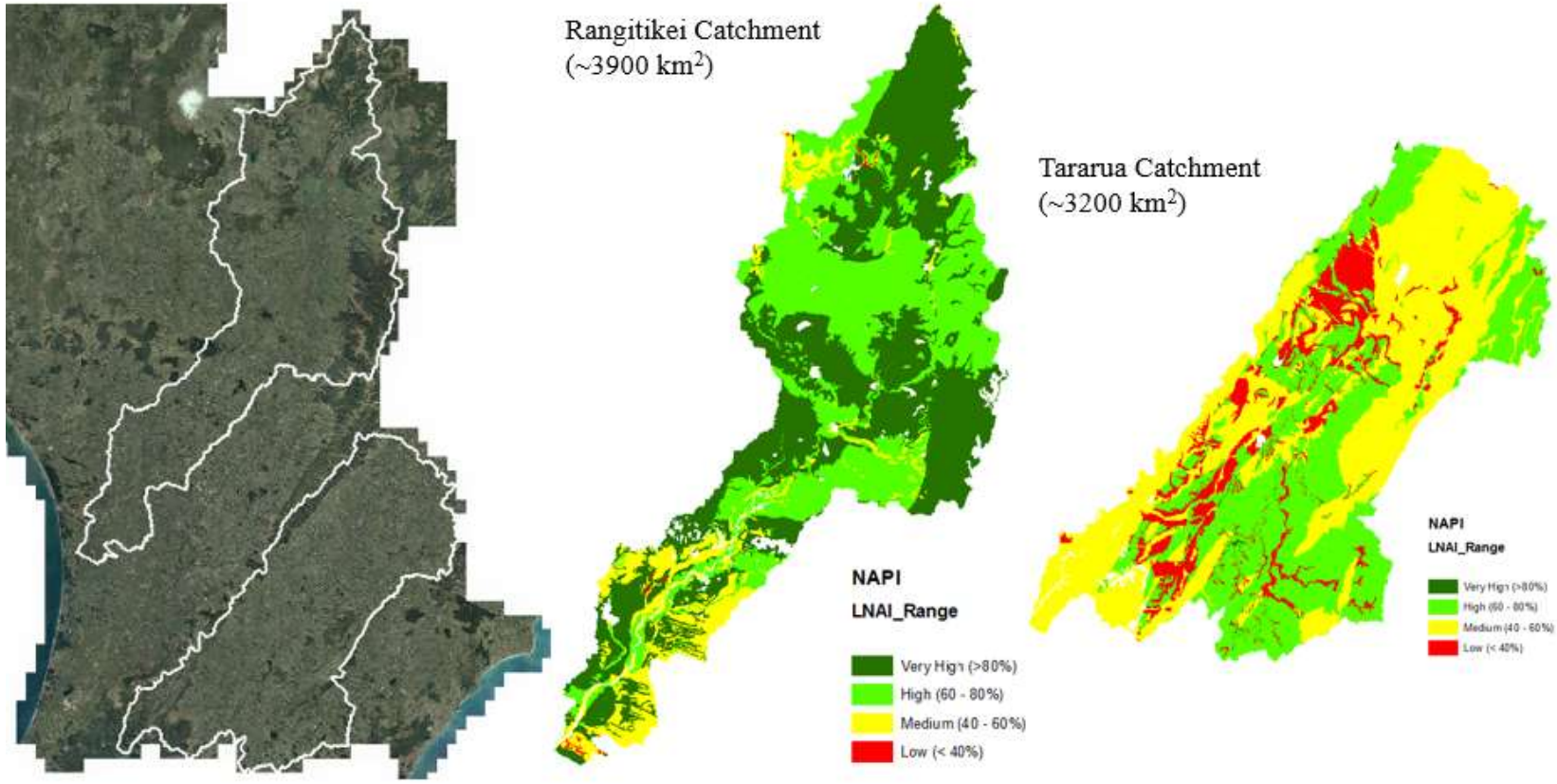
What is the solution?

Variable nitrogen attenuation capacity at a finer scale



QUANTIFYING ACTUAL DENITRIFICATION IN GROUNDWATER SYSTEMS

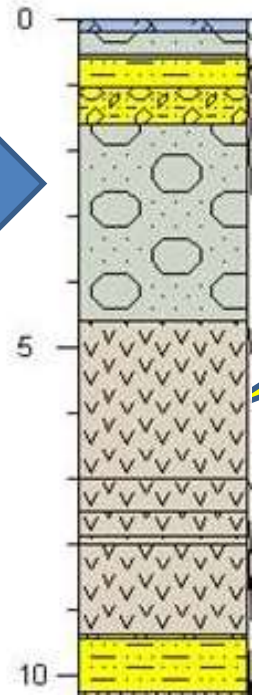
- Can now quantify the end product (excess N_2) from the denitrification reaction

$$NO_3 \rightarrow NO_2 \rightarrow NO_{(g)} \rightarrow N_2O_{(g)} \rightarrow N_{2\,(g)}$$

- By combining this with age the rate of denitrification can be found
- With enough data a 3D map of denitrification rates could be developed
- Knowledge of where and how much nitrate loads are mitigated by natural denitrification processes can aid land use planning to improve water quality

Potential nitrate source

Nitrate flows into groundwater system



30% nitrate removed from system in 2 year old water

70% nitrate load remains in groundwater system

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Who is using the research to make a difference?

- Farmers (and their advisors) can use this research to position their systems for future challenges associated with compliance and production.
- Regional Councils can use this research to inform policy and the allocation of N leaching allowances so as to achieve water quality outcomes in an effective and efficient manner.

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How is it building towards the Our Land and Water goal?

Potential for strategic de-intensification and intensification of landuse in the Rangitikei catchment

Consider 3 scenarios:

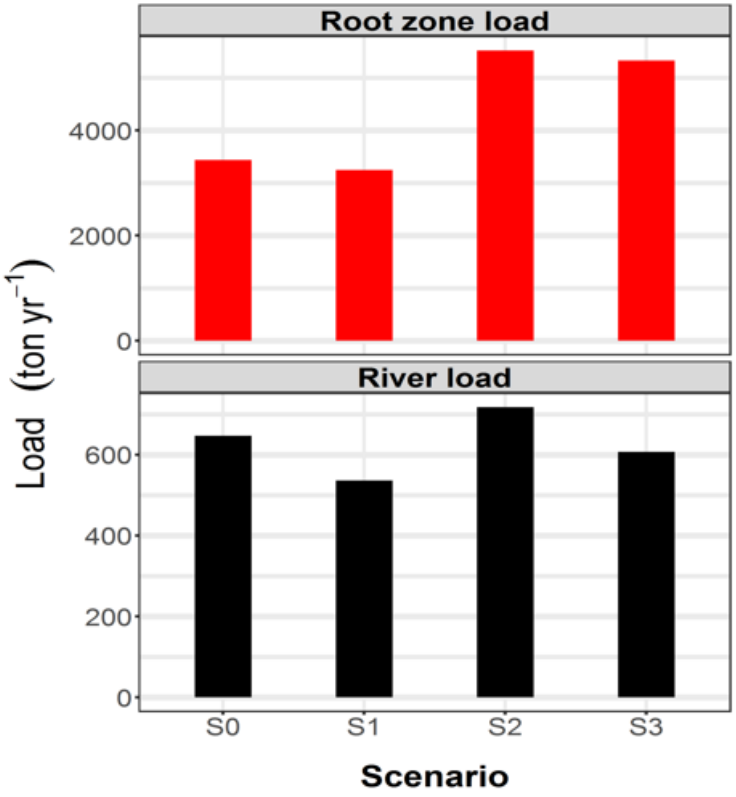
(S1) De-intensify landuse (< 15 kg N ha^{-1} yr^{-1}) on low-medium nitrogen attenuation potential areas (9,800 ha),

(S2) Intensify landuse (30 - 45 kg N ha^{-1} yr^{-1}) on high nitrogen attenuation potential areas (83,000 ha), and

(S3) Combination of de-intensify (S1) and intensify (S2) landuse scenarios above.

In scenario S3, overall the

- **Root zone N losses increased by 55%**
- **River N loads decreased by 6%**



- Farming the attenuation capacity will be a defining feature of future land uses and a key component of suitability criteria.

Collaborators

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FERTILIZER & LIME RESEARCH CENTRE

horizons regional council

DairyNZ

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More Information

Predicting Land-Based Nitrogen loads and Attenuation in the Rangitikei River Catchment – the Implications for Land Use

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